



Trigger Cost & Schedule

Wesley H. Smith, *U. Wisconsin*
CMS Trigger Project Manager

DOE/NSF Review
June 5, 2002

This talk is available on:

http://hep.wisc.edu/wsmith/cms/Trig_Lehman_C&S02.pdf



Cal. Trigger Status

Test Prototypes

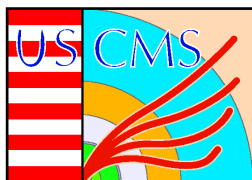
- New Proto.160 MHz Backplane - under test
- New Proto. Receiver Card - under test
- New Proto Clock Card - under test
- New Proto. Electron ID Card - under test
- Jet Summary Card - ready for manufacture

Serial Data Tests

- New Serial Link Test Card - under test
- New Serial Link Mezzanine Cards - under test

ASIC Prototype Tests

- All Prototype ASICs tested by Vitesse & Delivered
- Phase & BSCAN under test on Receiver Card
- SORT & Electron ID under test on Electron ID Card
- Adder ASIC validated on first prototype Receiver Card & production finished



Cal. Trig. ASICs & Cards

Component	# needed	Status
Backplane	18	2nd prototype being tested
Clock & Control Card	18	2nd prototype being tested
Receiver Card	126	2nd prototype being tested
Electron ISO Card	126	2nd prototype ready for test
Mezzanine Card	1026	2nd prototype Validated
Jet/Sum Card	18	Ready for manufacture
Serial Link Test Card	10	2nd prototype being tested
EISO ASIC	252	Ready for testing
Sort ASIC	576	Ready for testing
Adder ASIC	378	Validated - all in hand
Boundary Scan ASIC	1008	Under test
Phase ASIC	1026	90% tested

Spares not included



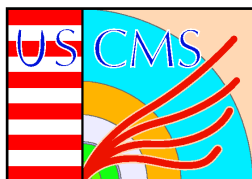
Cal Trigger Plans

Complete second generation prototype tests

- Complete Crate, Backplane, Clock & Control, Receiver Card & Electron Isolation Card testing
- Manufacture & test Jet/Summary Card
- Validate 4 remaining ASICs: Phase, Boundary Scan, Electron Isolation, Sort
- Complete testing of Serial Link Mezzanine Card Receiver, Transmitter & Tester Card

Integration in 2002-3:

- Integrate Serial Links w/ECAL,HCAL front-ends
- Test interface with Global Calorimeter Trigger
- Finalize Jet Cluster crate design



Future Cal. Trig. Milestones

Item	Event	Baseline Date	Update
ASICs	Prototype tested	Dec-01	Sep-02
CCC	Prototype tested	Dec-01	Jun-02
JSC	Prototype done	Jan-02	Nov-02
RC	Prototype tested	Feb-02	Sep-02
Backplane	Prototype tested	Mar-02	Jun-02
JSC	Prototype tested	Apr-02	Jun-03
EIDC	Prototype tested	May-02	Sep-02
ASICs	Production done	Jun-02	Oct-02
Backplane	Production done	Aug-02	Jan-03
CCC	Production done	Sep-02	Jan-03
CCC	Production tested	Oct-02	Mar-03
RC	Production done	Jan-03	Jun-03
EIDC	Production done	Mar-03	Jun-03
RC	Production tested	May-03	Sep-03
EIDC	Production tested	Jul-03	Sep-03
JSC	Production done	Feb-04	
Backplane	Production tested	Mar-04	
JSC	Production tested	Mar-04	
ASICs	Production tested	Mar-04	



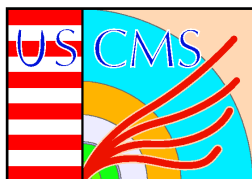
Muon Trigger Status

Compact Muon Trigger Design based on validated components

- **Single Sector Processor FPGA**
 - Verified can be done with a single Xilinx 1600E
- **New Backplane**
 - GTLP tested at 80 MHz
- **Higher bandwidth and more compact optical links**
 - TI TLK 2501 tested at 80 MHz parallel I/O
 - Radiation Qualified

New Prototypes being built or in final design/layout

- **Muon Port Card proto. with new optical links**
- **Combined Sector Receiver/Sector Processor proto.**
- **Proto. Backplane based on GTLP**



CSC Muon Trigger Cards

Component	Needed*	Responsibility	Status
MPC	48	Rice	2nd prototype being built
SR/SP	12	Florida	2nd prototype being designed
Clock & Control Board	1	Rice	2nd prototype tested
CSC Muon Sorter	1	Rice	Under design
Crates, Backplanes	1	Florida	2nd prototype being built
DDU readout	1	Florida/ Ohio State	Use EMU Readout

**Spares not included*



CSC Trigger Plans

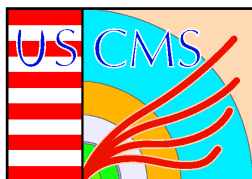
Prototype 2 and production follow EMU components to optimize technology

MPC, SP, CCC modules, backplane* milestones:

- **Apr-02 Prototype 2 designs done ✓**
 - Freeze CSC-DT interface
 - Determine DAQ interface w/ EMU readout
- **Nov-02 Prototype 2 construction done**
- **Apr-03 Prototype 2 testing done (begin EMU integration)**
- **Sep-03 Final designs done**
- **Oct-04 Production done**
- **Apr-05 Installation done**

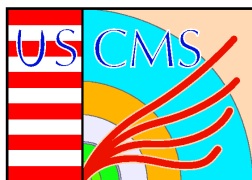
(*backplane schedule ~3 months ahead of above dates to provide platform for testing and integration)

Muon Sorter module: only 1, design by Jan-04



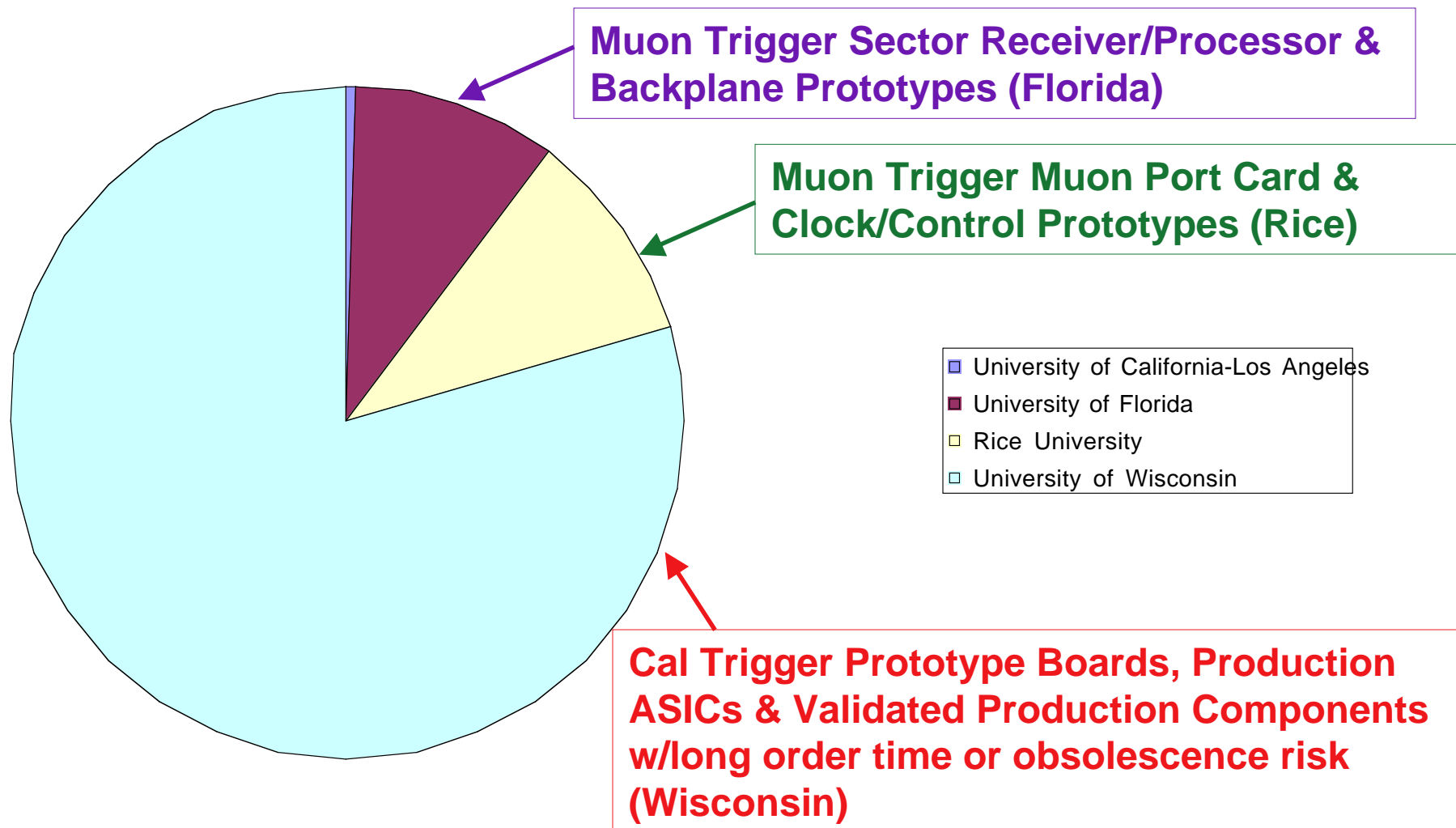
Future Muon Trig. Milestones

Item	Event	Baseline Date	Update
Bckpl	Proto done	Jun-02	Aug-02
CCB	Proto done	Jun-02	Aug-02
SR/SP	Proto done	Sep-02	Nov-02
Bckpl	Proto tested	Sep-02	Apr-03
MPC	Proto done	Sep-02	OK
CCB	Proto tested	Sep-02	Apr-03
SR/SP	Proto tested	Mar-03	Apr-03
MPC	Proto tested	Mar-03	OK
SR/SP-MPC-CCB	Tested	Jun-03	OK
Sort	Proto done	Aug-03	
Sort	Proto Tested	Nov-03	
Bckpl	Prod. done	Mar-04	
CCB	Prod. done	Mar-04	
Sort	Final Bd done	Mar-04	
SR/SP	Prod. done	Jun-04	
MPC	Prod. done	Jun-04	
Sort	Final Bd Test	Jun-04	
Bckpl	Prod. tested	Aug-04	
CCB	Prod. tested	Aug-04	
SR/SP	Prod. tested	Nov-04	
MPC	Prod. tested	Nov-04	



US Trigger FY02 Planning

Trigger SOWs FY02 -- \$1.7M





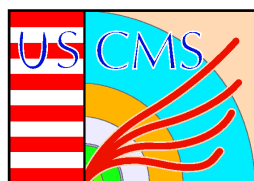
Schedule Performance

Schedule Changes since Lehman 2001:

- **Installation Date: Baselined: 3/04, Lehman '01: 11/04, Now: 3/05**
- **Trigger Sched.: Late wrt. Baseline by 5 months, wrt. Lehman '01 by 2 months**
- **Causes: wrt. Baseline (already discussed in Lehman '01)**
 - Single-crate Mu.Trig. Track-finder design → add'l design & prototyping
 - Adopt improved Cal. Trig. Vitesse Link chip → add'l design & prototyping
 - Adjustment of board proto. schedule to speed Cal. Trig. ASIC validation
- **Causes: wrt. Lehman '01:**
 - Mu. Trig.:SR/SP layout takes more time than estimated: integration of high density FPGA technology involves complex routing.
 - Cal. Trig.: Decision to make 2nd generation prototypes serve as the preproduction prototypes required more design effort -- helps later schedule

Observations: No Overall Schedule Slip

- **The activities that are a source of these delays are essentially complete**
 - Do not anticipate further slippage at this time.
- **23 month scheduled production + test time can be shortened to 18 months**
 - Based on experience -- fully recovers schedule
- **Schedule lag is less than installation date lag.**



Recent Trigger Milestone Performance (v31)

RCT Delays of 3-5 months:

- Reorganized board schedule to accelerate Vitesse ASIC testing

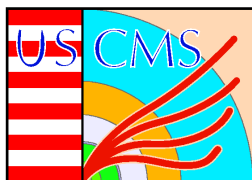
- Delay JSC since not needed for ASIC tests

- Success with 1st generation prototypes → make 2nd generation prototypes preproduction

- Longer design time delays testing

- Saves time later in schedule

Milestone	v31 Base	Current Start	Variance	'99	'00	'01	'02	'03
<input checked="" type="checkbox"/> Trigger Subsystem (WBS 1.3.1)	NA	Nov 30 '99	0 days					
Design of Final Sort ASIC	Nov 30 '99	Nov 30 '99	0 days	●				
Review of Calorimeter Trigger Control and Readout	Nov 30 '99	Nov 30 '99	0 days	●				
TK: SP Proto Design (Florida)	Nov 30 '99	Nov 30 '99	0 days	●				
CSC: MPC Proto Delivery (Rice)	Jul 31 '00	Jul 31 '00	0 days		●			
Review of Integration of Calorimeter Trigger Prototypes	Nov 30 '00	Nov 30 '00	0 days			●		
Submit Trigger Technical Design Report (TDR)	Dec 31 '00	Dec 31 '00	0 days			●		
RCT: CCC Proto Test Complete	Dec 31 '01	Jul 31 '02	148 days				●	●
Finish Trigger Final Prototype Design	Dec 31 '01	Dec 31 '01	0 days				●	
GCT: System Design Complete Not US	Dec 31 '01	Aug 31 '02	171 days				●	●
CSC: Bckpl Specified (DT Info)	Dec 31 '01	Dec 31 '01	0 days				●	
Regional Cal. Trig. - RC Proto Test Complete	Feb 28 '02	Jul 31 '02	109 days				●	●
RCT: ASIC Proto Test Complete	Mar 31 '02	Jul 31 '02	87 days				●	●
RCT: Bckpl Proto Test Complete	Mar 31 '02	Jul 31 '02	87 days				●	●
RCT: JSC Proto Test Complete	Apr 30 '02	Sep 30 '02	109 days				●	●
RCT: Electron ID Proto Test Complete	Jun 30 '02	Jun 30 '02	0 days				●	
Finish Trigger Final Prototypes	Jun 30 '02	Jun 30 '02	0 days				●	
CSC: C&CB Proto Test Complete	Sep 30 '02	Sep 30 '02	0 days				●	
RCT: CCC Prod Test Complete	Oct 31 '02	Oct 31 '02	0 days				●	
Finish Trigger Final Prototype Test Complete	Dec 31 '02	Dec 31 '02	0 days				●	
GCT: Integration Test Complete	Dec 31 '02	Dec 31 '02	0 days				●	
CSC: SR/SP Proto Test Complete	Mar 31 '03	Mar 31 '03	0 days				●	
CSC: MPC Proto Test Complete	Mar 31 '03	Mar 31 '03	0 days				●	
RCT: RC Prod Test Complete	May 31 '03	May 31 '03	0 days				●	
Finish Trigger Pre-Prod Design & Test	Jun 30 '03	Jun 30 '03	0 days				●	



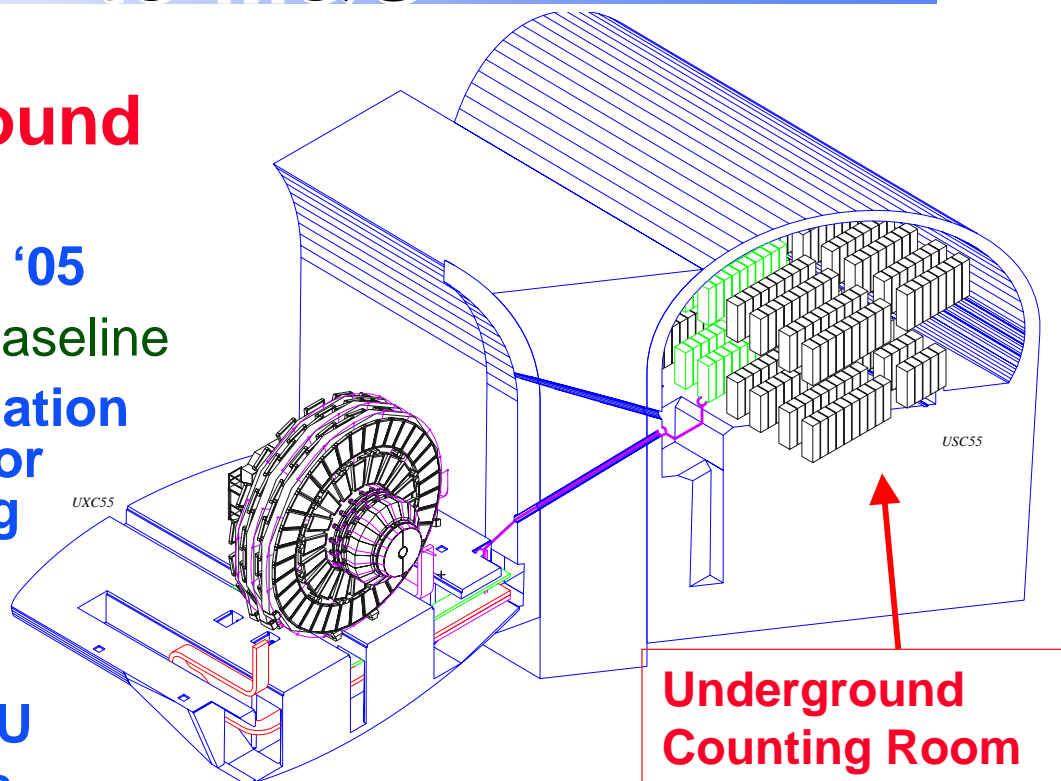
Completion & Transition to M&O

Installation in Underground Counting Room

- Expect access by March '05
 - Delay of 1 year from baseline
- Sufficient time for installation & some testing but not for complete commissioning with detectors

Slice Test (on surface)

- With both HCAL and EMU
- Verify trigger functions & interfaces by testing w/detectors on surface at CERN.
- Suggest as substitute for commissioning completion step.
- Will check as much on surface before gaining access to underground facilities.
- Planned for October '04 - March '05





Baseline Trigger L2 Task Schedule & Updates

Tasks	start	finish	new
• Produce TDR	8/00	12/00	✓
• Design Final Prototypes	11/00	12/01	✓
• Construct Final Prototypes	6/01	6/02 ⇒ 11/02	
• Test/Integrate Final Prototypes	12/01	12/02 ⇒ 4/03	
• Pre-Production Design & Test	6/02	6/03 ⇒ 11/03	
• Production	12/02	6/04	
• Production Test	6/03	11/04	
• Trigger System Tests	5/04	5/05	
• "Slice Test" (NEW) ←	10/04	3/05	←
• Trigger Installation	3/05	9/05	←
• Integration & Test w/DAQ & FE	6/05	12/05	←
• Maintenance & Operations	10/04	-----	←

6 months civil engineering delay of installation date

- With respect to date reported at Lehman '01



Cost Performance

Cost Increases since Lehman 2001:

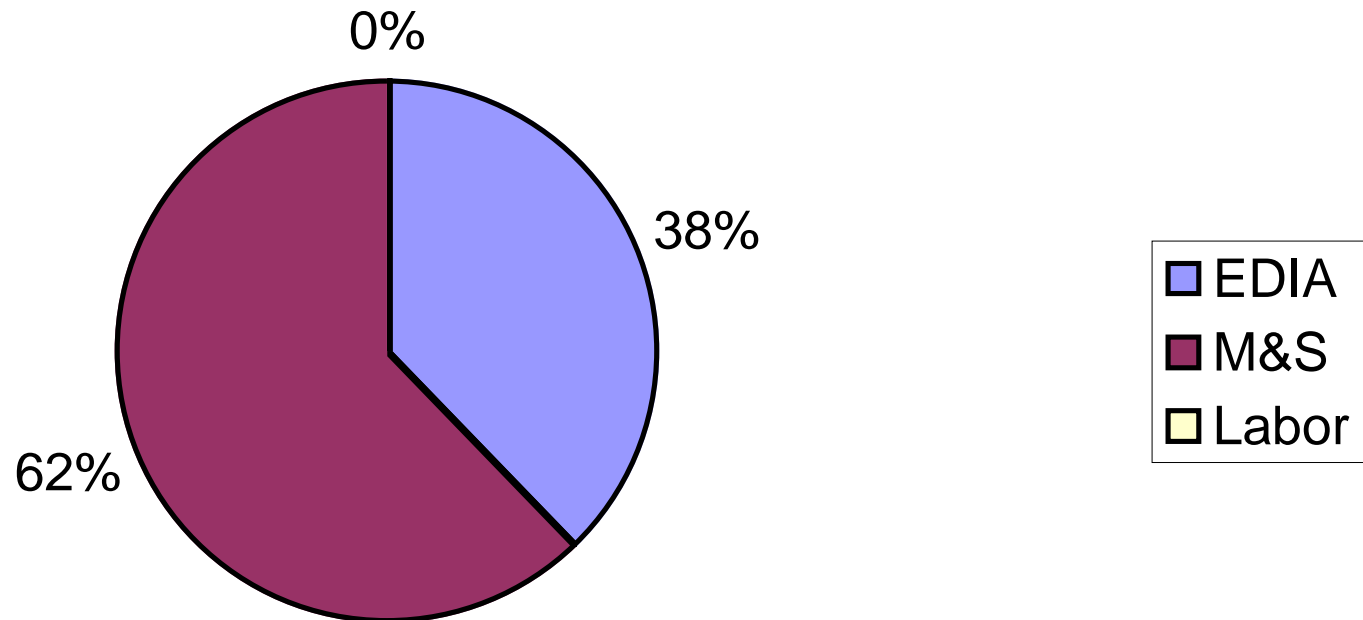
- **New CSC trigger Prototyping Phase: \$112K**
 - Needed to validate new compact 1-crate design
- **Loss of Cal. Trig. Base Program Engineer Support: \$77K**
 - Wisconsin engineering now on total project support
 - Implies further out-year cost increases at this level
- **Purchase of Cal. Trig. Adder ASIC spares: \$25K**
 - Production complete, but foundry line transition implies large cost increase for additional units of this ASIC only.
 - Remaining stock from existing production bought cheap
- **Project Support of Cal. & CSC Trigger Slice test: \$65K**
 - Engineering & testing of additional modules
 - Does not cover additional base program needs (postdocs & students)
- **Production of additional Cal. Trig. Serial Link Integration Kits: \$59K**
 - Testing of ECAL, HCAL interfaces will speed slice test, commissioning

Cost of prudence & outside events: \$338K/\$8.5M = 4%

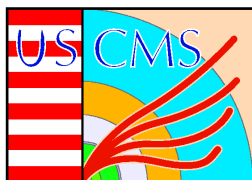


US Trigger Estimate-to-Complete

US Trigger Estimate-to-Complete = \$4.6M AY
1998 Project Baseline Total Cost = \$7.6M AY
2002 Project Total Cost = \$8.5M AY

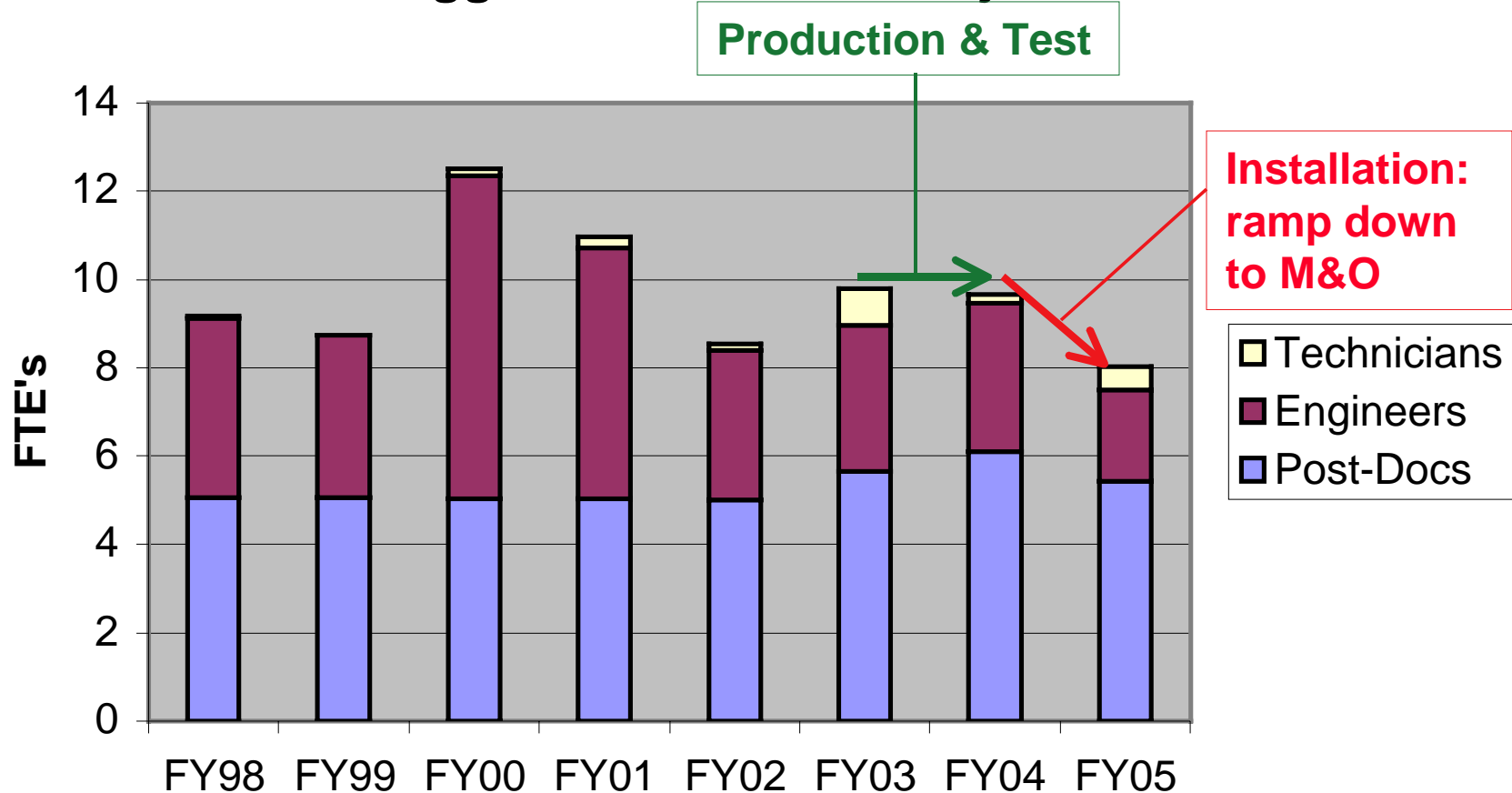


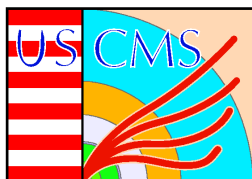
As of May '02 Trigger Project is 46% Complete
Costs up 12% over '98 baseline (50% contingency)



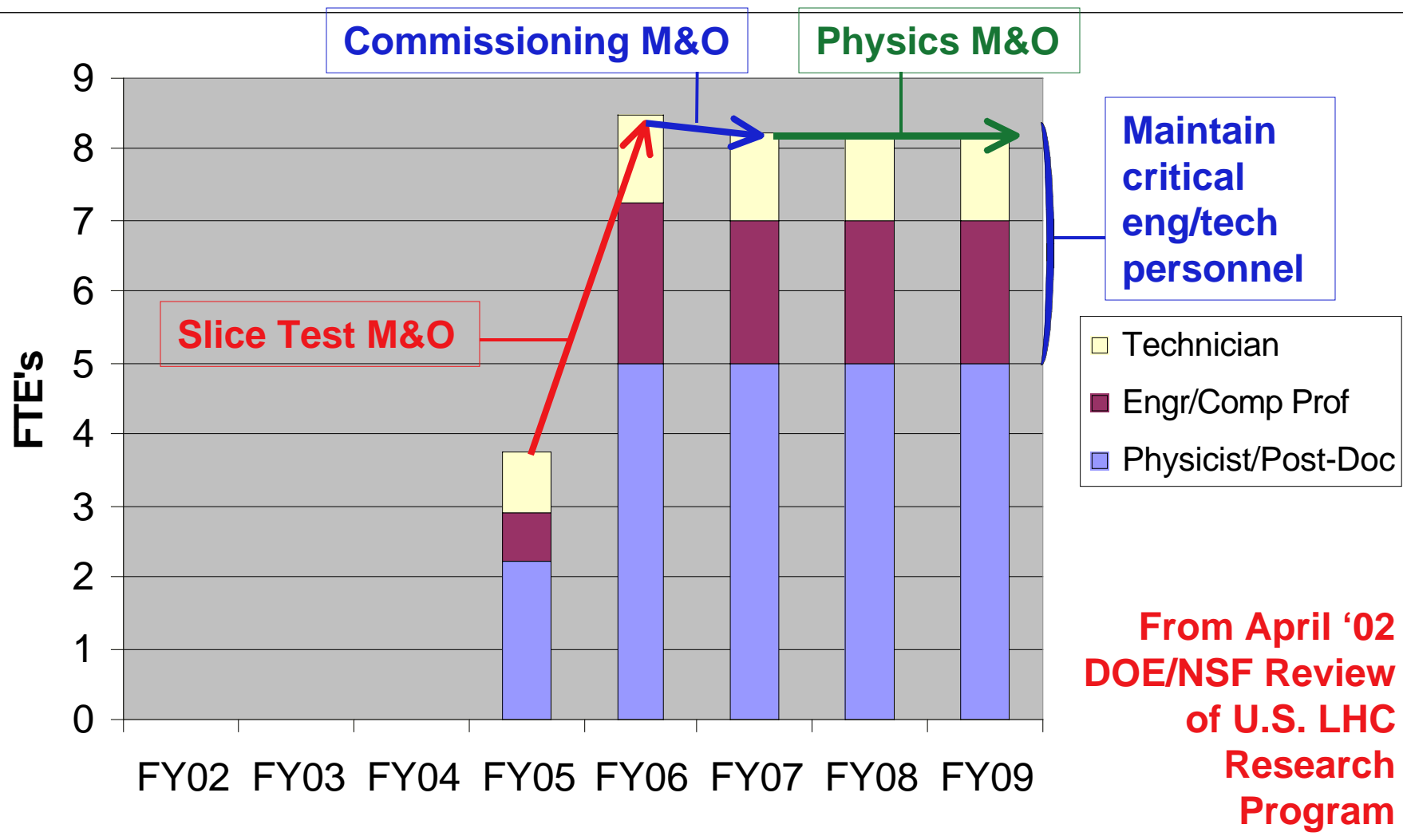
US TRIG Project Resources (FTE's)

US CMS Trigger Construction Project Resources



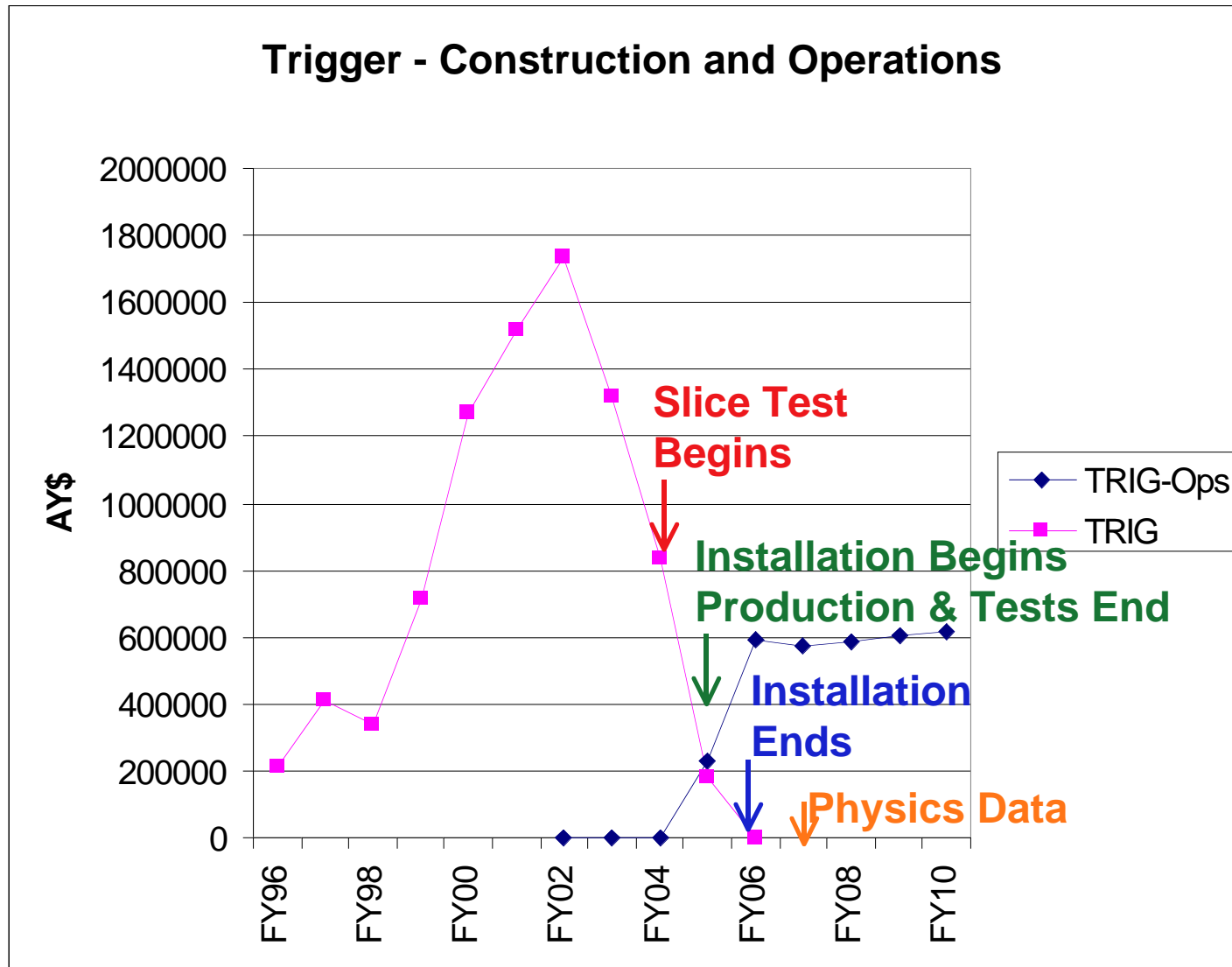


US Trigger M&O Resources





Trigger Commitments





Trigger Project Management

CMS TriDAS Reviews (besides this)

- **April: TriDAS Status**
 - Progress, draft R&D plans & expenses for next year
- **May: Electronics Systems Review**
- **September: CMS Annual Review**
 - With CMS & external referees
- **October: LHCC Comprehensive Review**
 - LHCC subcommittee +external experts
- **November: TriDAS Annual Review**
 - R&D Plans/Progress, Cost & Schedule, Milestones
 - Finalize R&D plans & expenses for next year
 - Internal Annual CMS Review w/external & CMS referees



Trigger Project Management

US CMS Management

- **US Reviews**

- Monthly Video Conferences
- Florida, Rice, UCLA, Wisconsin
- Review Progress, milestones, simulation activities

- **US Reporting**

- Monthly progress reports:
 - % complete
 - activities narrative

- **US Integration Trigger Meetings:**

- Calorimeter: Boston U., FNAL, Maryland, Wisconsin
- Muon: Ohio, Florida, Rice, UCLA, Wisconsin, others.

- **US Trigger Site Visits: Florida, Rice, UCLA**



Concerns

Installation Schedule

- New schedule has reduced installation time
- Significant time needed for integration in a synchronous pipelined system.

Base Program Manpower

- Major effort on trigger software required
 - Tasks include monitoring/controls, diagnostics, configuration downloading and documentation, modeling, physics simulation, etc.
- Major effort on testing & installation
 - Planned as activity of base program manpower
- New Major Effort on “Slice Test”
 - Motivated by installation delay
 - Also needs base program manpower



Conclusions - Trigger

Good Progress Since May 2001 Lehman Review

• Second Generation Prototypes

- Cal. Trig. Protos: under test (ex. Jet Summary ready to build)
- Mu. Trig. Protos: being built or in final design/layout
- Final Mu. Trig Links validated, Final Cal Trig Links under test.
- All since last review

• Cost & Schedule Performance

- Cost increase of 4% since Lehman '01, 13% from '98 baseline is less than planned 50% contingency for 46% completion.
- No overall schedule delay: < 5 month lag compensated in reduced (18 month) production and 1 year installation delay.

• Project Management

- Extensive system of reviews and monitoring is working
- Detailed documentation(including TDR) on WWW:
<http://cmsdoc.cern.ch/ftp/afscms/TRIDAS/html/level1.html>

Concerns: Manpower (Base Prog.), Installation Schedule